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Rural Equitable Economic Growth Activity

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RURAL EQUITABLE ECONOMIC GROWTH ACTIVITY

Contract No. 519-C-00-94-00154-00

REVIEW OF THE CASHEW OPERATIONS OF SISTEMA ECONOMICO SOCIAL (SES), AND ORGANIZATION OF THE EUROPEAN UNION. SAN CARLOS, SAN VICENTE DEPARTMENT, EL SALVADOR.

Prepared by:
Ian Duncan
National Cooperative Business Association

Through:

Chemonics International Inc.
Instituto Interamericano de cooperación para la Agricultura (IICA)
National Cooperative Business Association (NCBA)
World Council of Credit Unions (WOCCU)
U. S. Agency for International Development (USAID)
El Salvador

May 1999

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This report was supported by the U.S. Agency for International Development, through Contract number 519-C-00154-00, the prime contractor for which is Chemonics International Inc., 1133 20th Street, Washington, D.C. 20036, Tel.: 202-955-3300; Fax: 202-955-3400.

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SUMMARY EXECUTIVE

SES (Sistema Economico Social) is an EU (European Union) supported organization that is providing assistance for economic and social development in San Vicente division in El Salvador. As part of this assistance program SES is supporting a cashew project by the communities around San Carlos. This project is proposed to produce organic product - this prohibits the use of artificial fertilizers and chemical insecticides.

This cashew project to date has involved planting 137 manzanas of seedling trees between 1995 to 1998 (10,625 trees) in 12 different communities. Some of these planting are on suitable sandy soils while others are on less suitable soils which appear to have a higher clay content. Cashew is a tropical tree crop that likes a well-defined wet and dry season. Climatic data from the nearby Santa Cruz station shows that the temperature regime is very suitable but there may be some years where the length and timing of the wet season may cause limitations in the crop.

The current cashew crop is about 30 MT from the old planting at Monte Christo. The consultant estimates that the new planting will increase the crop to about 106 MT by year 2009. The consultant found that the state of tree growth in the new planting to be quite reasonable, but there may be some nutrient deficiencies and there was evidence of some damage caused by insect pests and disease. The SES nutrition program involves one application of 5 lbs of compost per year but no analysis has been made of either the nutrient status of the trees or of the nutrient value of the compost. The major pests are *Leptoglossus sp* and to a lesser extent *Selenothrips rubrocinctus* and they have the potential to cause significant damage. At SES neem is being used against insect pests but it´s previous use elsewhere in El Salvador have not been particularly successful.

The fungus disease anthracosis is also a potential significant problem and the currently methods of control include correct canopy management and copper sprays where necessary. This control measures appear to be only partially successful in El Salvador.

SES is also currently constructing a processing factory using the hot oil bath processing system with a capacity to process 140 MT of raw nuts per year. There will also be facilities to produce by-products of cashewnut shell liquid (CNSL), and juice and dried fruit from the cashew apple. The processing factory will be operational later this year.

The consultant makes the following recommendations:

A. Plantation

1. Soil profile analysis should be undertaken of potential new plantation sites. It is preferred that new planting are made on suitable sandy soils with a pH of 5.5 to 7.0. (section 4.3)

2. Cashew trees planted from seed can be highly variable, the only way to obtain a uniform high standard is to planted selected grafted clonal trees. SES should commence a genetic improvement program so that in the future it will be in a position to plant superior grafted trees rather than to continue planting seedlings.

   This improvement program can be viewed in two parts:

1. A full selection program would involve (a) a nursery and (b) budwood block. Progeny from selected parent trees are propagated in the nursery and then planted in the budwood block. The performance of the clonal trees in the budwood block must be monitored and once proven these same trees provide the vegetative material for the large scale production of grafted trees. (section 4.1).

   The advantage of the full selection program is that it gives the best results, the disadvantage is that it will some years (5 + years) to evaluate the selections and start large scale propagation for use in the field.

2. An interim selection program only requires use of a nursery. The process involves using scions from selected parent trees for grafting and planting the new trees in the field. The advantage of this system is that it is fast, the disadvantage is that the supply of superior trees that can be produced but this scheme will be very limited.

   The consultant recommends that SES consider using both the Full and Interim selection programs. The scale of the interim program should be limited so as not to adversely effect the full program.

   SES should select the best of the mature cashew trees at Monte Christo as the source of the parential material, however this genepool is very limited in variation. Therefore SES should import new genetic material especially Brazilian dwarfs which are early bearing and allow high density planting.

   These Brazilian dwarfs should be planted in the budwood nursery for evaluation as part of the full selection program.

3. Nutrient analysis is required to determine nutrient content of the compost applied and a foliar analysis is required to determine the nutrient status of the cashew trees. This will allow a more targeted nutrient program in terms of volume/ timing of compost applications. In addition the nutrition program is almost certainly likely to include foliar applications of micro-nutrients (probably zinc, copper etc) which have been found to be important in cashew. (section 4.3).

4. Pest and disease management. The pest problem at SES is similar to the problems faced at CORALAMA and has the potential to cause significant loss of crop. The previous use of neem as a control measure at CORALAMA was not effective. SES requires a systematic program to control the major pests of *Leptoglossus sp* and *Selenothrips rubricinctus.*

Currently RECER is supporting a research program at the University of El Salvador which is investigating biological control methods and the consultant is also recommending the introduction of the species *Oecophylla smaradgina* which has proven successful in Australia as a natural predator of many cashew insect pests. The consultant recommends that SES join RECER in supporting the proposed research programs for mutual benefit.

Anthracosis is a fungus disease that can also cause significant crop loss, the traditional control measure of copper applications and tree pruning appear to be only partially successful. The consultant is recommending to CRECER that some additional work be undertaken at the University of El Salvador to investigate the cycle of infection in cashew plantations as a prelude to improved control measures. The consultant also recommends that SES should join this proposed program. (section 4.2).

5. Tree spacing - as cashew trees only bear fruit on the canopy surface, the correct tree spacing depends on canopy size and shape. Until new grafted trees are produced in any genetic selection program SES should re-assess it´s policy on spacing. The current spacing used with no inter-planted crops is unbalanced at 12 by 6 meters (79/manzana). The consultant suggests new spacing either of 8 by 8 meters (90/manzana) or 9 by 9 meters (70/manzana) depending on anticipated tree size and shape).

B. Processing Factory

SES has made it´s decision on the type and scale of processing factory to be installed. The consultant makes some comment on the chosen nut processing system in section 3.8. In his interviews the consultant found that SES staff appeared to have some limited experience in processing with the chosen hot oil bath system as they previously operated a somewhat crude factory. The consultant concludes that SES would benefit from technical support. While some experience is available in El Salvador (CORALAMA), technical support in the use of hot oil bath equipment may have to come from external sources.

SES also plans to extract and market the by-products CNSL and cashew apple products. The consultant notes that CNSL extraction will only provide about 2 % extra revenue (CNSL volume is 8 % of raw nut at say US$ 300/MT) and he suggests that careful analysis of the additional capital, operating costs and markets is required to indicate whether this extraction is cost effective.

In addition the commercial processing of cashew apples will require the additional costs of virtual daily harvesting, together with local market development costs as there is no significant export market for cashew apple products.

**REVIEW OF THE CASHEW OPERATIONS OF SISTEMA ECONOMICO SOCIAL (SES), AND ORGANIZATION OF THE EUROPEAN UNION.
SAN CARLOS, SAN VICENTE DEPARTMENT,
EL SALVADOR.**

1. Background Information

A1. Organizational Structure

The European Union (EU) is involved in providing assistance for economic and social development in El Salvador. Their program Foundation for Cooperation and Communal Development of El Salvador Region Three operates in San Vicente department and part of La Paz department. In region three there are three separate micro-regions, these are SES (Sistema Economico Social), MES (Microregion Economico Social) and IDES (Iniciativa para el Desarrollo Economico y Social). Both SES and MES operate in SanVicente department, SES works south of the village of Tecoluca while MES is located around and north of Tecoluca. IDES operates south of the town of Zacatecoluca in La Paz department.

The three organizations are involved in organic crop production, certain livestock production, Eco tourism, aquiculture, fishing, agro-industry and the development of natural resources in their regions. The combined area of operation covers an area of 13,341 manzanas, 38 communities with a total population of 9,190 people.

SES commenced operations in 1992. Within it´s overall agriculture program there is a cashew development component that includes (1) new cashew planting in all the communities that wish to participate, (2) a processing factory and marketing of the crop. It is understood by the consultant that the communities will manage their own cashew planting with some technical assistance from SES and SES will manage both the processing factory and the marketing of the crop. In addition the neighboring development organization MES is also commencing the support for small scale the planting of cashew trees by communities in his area.

The consultant was requested to make inspections of the SES cashew developments and write a report on his conclusions. He conducted field inspections of SES cashew planting and the processing factory and conducted interviews with some community members and SES staff within the program area. He also made a brief inspection of the MES area prior to the writing of this report.

A2. Description of Project Area

The area of the cashew development at SES is in the area south of the Litoral highway and mainly in the area bordering the Lempa river between El Pacun and La Pita. An earth road of average standard to the Litoral highway provides access to the area. Mains power lines are situated along the La Pita road and this supplies power to the majority of the community housing which is situated adjacent to the road. Water supplies for domestic and other uses are provided by wells and especially by the Lempa River to communities located near the river.

The topography of the area is mainly level with an altitude of no more than 10 meters above sea level.

The vast majority of the adult population in the project area are engaged in agricultural pursuits within the communities, there are no significant sources of alternative paid employment in the project area. The nearest sizeable town is Zacateculuca, which is about 35 km from SES headquarters at San Carlos. The major crops grown in the area are maize and bananas and other fruits.

2. SES Cashew Developments

The following is a description of the developments to date as ascertained by the consultant.

B1. Cashew Planting

Some 36 manzanas (24 hectares) of cashew seedling trees were planted on Monte Christo island near the mouth of the Lempa river in the 1970´s. The origin of the original seed for these planting is unknown. These trees can now be considered mature (25 + years) and prior to the SES developments, the only significant stand of cashew trees in the whole district. The crop from Monte Christo has been harvested for a number of years and has either been sent to the factory at CORALAMA for processing or has been locally processed in the communities using very crude manual methods.

The consultant was advised that the total crop from Monte Christo has varied from 630 to 750 quintals over the past couple of years (28 - 34 metric tons, MT raw nuts).

The SES program for cashew production involves using the Monte Christo planting as the base for new planting in the communities. This involves using the seed from Monte Christo as source material for planting new trees in the areas that set aside for cashew planting in the communities. A complete list of the planting are as follows:

Community	Area Planted (Manzana)	Date Planted (June)	Total No of Trees
El Naranjo	15	1995	950
San Carlos	10	1995	650
	8	1998	1,050
Anonas	5	1995	325
Rancho Grande	10	1995	650
	10	1997	650
El Coyol	5	1995	325
	5	1997	325
Puerto Nuevo	5	1995	325
	10	1997	650
El Pacon	10	1997	650
Taura	5	1997	325
Santa Marta	5	1996	325
	15	1997	950
San Bartolo	4	1998	525
Provenir	5	1998	650
Monte Christo	10	1998	1,300
	--------		---------
	137		10,625

In addition there are the 36 manzanas of mature trees (25+ years)at Monte Christo with a total number of about 2,000 trees.

All new planting between 1995 and 1997 were made on 12 meters by 12 meters and the cashew are inter-planted with maize, bananas and paw. In 1998 it was decided to plant cashew at the higher density of a 12 meters by 6 meters spacing without any inter-planting with other crops.

The consultant was advised that SES intend to continue planting new trees in the next few years, including 8 manzanas in the neighboring development area of MES.

B2. Cashew Management and Inputs

The cashew trees are managed by the members of the communities with advice provided by the SES technicians. No inputs are used in the 36 manzanas of mature cashew trees at Monte Christo. On the new planting the inputs include applied nutrients in the form of one application per year of 5 lbs of compost . and this application is usually made about June. There has been no nutritional analysis of the ingredients of the compost.

In addition applications of neem and copper are made for the control of insect pests and *anthracnose* respectively where necessary. These applications are made on foot using back pack sprayers.

B3. Cashew Processing

Up to now the only crop available to SES has been the approximate 30 MT of raw nuts from the mature tree planting at Monte Christo. These nuts have been processed in the communities utilizing primitive methods (shelling using rocks).

However recently a new organization, SAMO (Sistema Agroindustrial del Marañon Organic) supported by EU has been set up to manage the processing of cashew. This project involves the construction of a new processing factory at San Carlos, together with buildings, machinery and ancillary facilities. At the time of the consultant=s inspection the buildings were almost complete, however virtually no equipment had yet been installed. Information provided to the consultant indicated that the following budget had been submitted for the construction and installation of the factory:

			US$
Buildings and infrastructure			139,800
Processing equipment	-nuts	35,050	
	-oil	27,488	
	-dried fruit	20,522	
	-cashew apple	4,947	88,008

			227,808

Additional advice indicated that up to June 1998 some 1,624,448 colones (US$ 184,500) has been spent on the factory project. The consultant was advised that the proposed factory start up time was in May 1999.

The design of the processing system at SES is ahot oil bath method one of three possible systems in use worldwide (the others being dry roasting and steam treatment). The consultant is unaware of any feasibility study undertaken by SES to evaluate processing options prior to the commencement of this project.

The design details of the proposed SES factory available to the consultant are as follows:

Processing capacity :	140 MT raw nuts p.a. (assuming one 8 hour shift for 10.5 months).
Nut preparation :	Hot oil bath, capacity of 572 kg raw nuts per day. Equipment designed by Professional de Consultores Proyectos y Servicios SA.

Shelling: Semi manual machines (10). To be supplied by Pearce Ind. E. Com de Maquinas of Brazil. (an equipment supplier). Two workers/machine with capacity to shell about 30 - 40 kg raw nuts/day.

In addition equipment associated with collection of Cashewnuts shell liquid (CNSL) and the processing of cashew apples to produce other by-products would be installed in the future.

The consultant=s discussions with the SES technical staff on site suggested that collectively they had limited experience in cashew processing relative to the scale of operation they are embarking on.

B4. Marketing

The consultant was advised that previously the cashew kernels obtained by processing of the Monte Christo crop was marketed by Agrodesa, (SES marketing body). Apparently kernels have been sold in UK but no details on volumes and prices were available to the consultant.

C. Consultants Analysis and Comments

Cashew originated from NE Brazil and is a tree of the tropics which performs best under warm to hot conditions and where there is a well defined dry season.

The ideal climatic characteristics for cashew could be summarized as follows:

Temperature, 27 degrees C as average temperature considered ideal or flowering and fruiting ranging from max of say 32 to minimum of 24 . However cashew may grow well outside this range provided maximum and minimum are not extreme. Temperatures above 40 degrees C and below 5 degrees C could be harmful. In particular young trees are susceptible to frost.

Rainfall: For cashew grown under rain fed conditions a range of a minimum of 800 mm to 1,500 mm over about five to six months of the wet season is usually given as the preferred distribution pattern.
(note, cashew can be considered drought tolerant trees but only when they grow on deep soils where their roots can penetrate to reach moisture at lower levels).

Relative humidity: There is no data on optimum conditions for cashew but it does grow well in a range of humidity (in Brazil from 50% semi arid regions to exceeding 80% on the coast). However high humidity are also suitable conditions for diseases *(anthracnose)* and insect pest survival.

Sunlight: There is no data on effects of day length, as a tropical tree it can be onsidered sun loving with preference for days and nights of equal length.

Altitude: Is relevant in so far as it effects temperature. The largest concentrations of cashew are found on coastal strips where altitude does not exceed 600 meters.

Wind: Wind is not relevant for pollination as cashew is insect pollinated. However cashew trees are susceptible to damage in strong winds or storms. In addition the growth habit of very young trees can be effected by strong prevailing winds.

There is no climatic data available in the SES project area as no recordings are taken. However data available from the Santa Cruz meteorological station (some 20 km from SES project area) indicates the following:

Table 1

Temperature - degrees C

	Absolute Maximum	Absolute Minimum
Jan	40.4	10.6
Feb	40.5	14.0
March	41.8	15.3
April	40.8	15.5
May	42.4	19.3
June	39.4	16.5
July	39.6	17.2
August	38.5	18.5
September	37.7	17.0
October	37.0	15.6
November	38.3	14.2
December	39.4	14.0

It can be included that the temperature regime is ideal for cashew.

Rainfall data was available from the Santa Cruz Porrillo for the years 1990 to 1998 as follows:

Table 2
Monthly Rainfall (mm) for 9 Years (1990 to 1998)

	Average per Month	Extreme Range Max	Extreme Range Min
January	0.6	5.8	nil
February	0	0	0
March	7.2	33.0	0
April	46.6	107.2	0
May	118.6	318.5	0
June	288.2	508.3	0
July	234.0	467.5	109.9
August	299.6	586.7	125.0
September	326 4	509.3	109.5
October	237.1	584.0	124.1
November	107.3	481.0	0
December	17.5	49.0	0

	1,638.1		

Extreme dry season (December - April) maximum	- 107.2 mm April 1993
extreme (wet season (May to November) minimum	- 0 mm April, May June

The total average rainfall of 1,638 mm is within the optimum requirement. Provided the trees are grown in the preferred soils they will develop a good root system and the total amount of rainfall received should prevent any significant water deficiency problems.

The preferred length of dry season is 5 - 6 months of minimal rain to allow a good sequence of flowering and fruiting to occur. In the nine years of available data (1990 - 1998) there was one year (1990) where the dry season was far too short at about 2.5 months duration. There were two years (1992, 1993) where the dry season was barely long enough (3.5 - 4.0 months), and one year (1996) where the dry season at 7 months was slightly too long. In the remaining 6 years the dry season at between 4 to 5.5 months was quite acceptable. It can be concluded that perhaps two or three times per decade the crop may be somewhat adversely effected by an unfavorable rainfall pattern.

Comment should also be made on the relationship between the timing of the start of the wet season and the period of harvesting. Peak harvesting period in El Salvador would appear to be April, with some crop frequently coming in May. The data shows that in five of the nine years the wet season had effectively commenced in May with monthly rainfall figures of 214.6 mm, 318.5 mm, 161.1mm, 111.1 mm and 108.5 mm. As timing of fruiting and flowering is strongly influenced by genetics it must be recommended that this characteristic be a significant component of any future genetic improvement programs.

Data on relative humidity from Santa Cruz is as follows:

Table 3..

Relative Humidity (average of readings 9am and 3pm)
(26 years of data)

January	- 63 %
February	- 63 %
March	- 64 %
April	- 69 %
May	- 75 %
June	- 81 %
July	- 84 %
August	- 84 %
September	- 82 %
October	- 82 %
November	- 74 %
December	- 66 %

The levels of relative humidity are probably higher than would be considered ideal far cashew as higher humidity is conducive to higher potential insect pest problems and especially disease problems such as anthracosis.

C1. Soils

The best soils for cashew are deep, well drained sandy loam soils without any hard pan or soil compaction. Cashew cannot stand bad drainage areas and they perform poorly on shallow soils. A pH condition of about 5.5 to maximum of 7.0 with a soil depth of a minimum of two meters is preferred. A soil profile of 80 % or higher of sand would be optimal, a silt/clay content of more than about 40 % would be less than appropriate. It is important to note that correct soil structure is more important than inherent soil fertility as in the appropriate deep soils the cashew tree can develop it´s deep and extensive root system to collect it´s required moisture and nutrients from a large area. In contrast any inherent soil nutritional deficiency can be corrected by applied nutrients.

There is no information on the soil profile at SES as no analysis has been carried out . A visual inspection by the consultant indicated that cashew was planted on a range of soils from apparently quite suitable at Anonas which had sandy soils to apparently much less suitable at some other sites (including El

Naranjo) where the signs were of higher clay content.

The consultant also has no information about the soil nutritional status at SES, apparently some analysis was undertaken previously which indicated that nitrogen (N) was deficient.

The consultant concluded from his visual inspection that there were signs of deficiency in a number of trees at a number of locations. These symptoms could be deficiencies on nitrogen, and potassium and probably some micro-nutrients. The only way to determine a true nutrient status for the trees would be to undertake a foliar analysis of the cashew trees.

C2. Genetic Improvement

Cashew is a heterogeneous open pollinated tree and therefore there can be enormous genetic variation within the seed. The only method of obtaining a strict tureens to type in progeny is by in-vitro propagation. This technique has not yet been perfected in cashew. Propagation by cuttings has previously been tried in many places but has not been successful.

Currently the only practical vegetative propagation method is by grafting or budding techniques. With these methods some variation still remains within progeny of a parent and this is caused by the scion/rootstock interaction. As yet little research has been conducted on rootstock interaction.

As indicated above variation in seedlings can be enormous - for example a survey of 128 three year old seedling trees at Nachingwea research station in Tanzania showed yields ranging from 0.4 kg to 6.8 kg per tree (average yield per tree 2.6 kg). In contrast the relative consistency of grafted trees is shown in Australia where 18 trees of one variety had an average yield of 16 kg/tree, this ranged from 13 to 20 kg for individual trees (consultant=s private data).

There are a number of criteria involved in the selection process and the three most important are as follows:

1.	Total yield	- Determined by both genetics and environmental/management.
2.	Kernel size	- Largely determined by genetics.
3.	Recovery %	-Largely determined by genetics.

Other selection criteria of importance that are largely determined by genetics are as follows:

5. Time of fruiting

4. Tree shape

6. Size of apple (only if the apple is an important product to be exploited)

An upright tree shape is important to allow a denser planting while early fruiting varieties will ensure that harvest occurs before the rainy season. Large apples are only relevant if a significant commercial market exists for apples products.

The main emphasis should be on the three key criteria of yield , kernel size, and recovery % which have the major impact on the value of the major product produced, but also can have a significant impact in the processing factory.

Firstly, larger kernels fetch higher prices, a sample of the relationship between grades and market prices is as follows:

Grade	Price (US$ per lb)
W180	3.20
W210	2.90
W240	2.70
W320	2.40
W450	2.15

Secondly, a crop that has a recovery rate of 30 % will yield a 50 % higher yield of final product than a crop with a recovery rate of 20 %.

The following table based on the theoretical results from a single tree demonstrates the following, the table ignores broken grades for simplicity:

Example 1.

Tree A		Total Value US$
Total yield	- 5 kgs	
Kernel size	- W 320	
Recovery- 20 %		
Tree A yields 1 kg kernel (2.2 lbs)		
	- 50% wholes @ US$ 2.35/lb	
	- 50 % broken @ US$ 1.50/lb	3.85

Example 2.

Tree B		Total Value
Total yield	- 5kgs	
Kernel size	- W210	
Recovery- 30 %		
Tree B yields 1.5 kgs kernel (3.3 lbs)		
	- 55 % wholes @ US$ 2.90/lb	
	- 45 % wholes @ US$ 1.50/lb	7.49

In the theoretical examples above both tree A and tree B have the same total yield. However improvements in kernel size and recovery rate for **tree B gives 90 % more value than tree A.**

In addition the processing of product from tree A will have significantly lower unit costs than tree A. There are a number of elements to this benefit, these are as follows:

1. The costs of shelling raw nuts is virtually identical regardless of what the recovery rate is. Therefore if the labor cost of shelling 1,000 kgs of raw nuts is US$ 80, then if recovery rate is 20 %, unit shelling cost of 1 kg of kernel is US$ 0.40.

   If recovery rate is 30 % unit shelling cost of 1 kg of kernel is US$ 0.26.

2. Larger kernels are easier to process so workers will break fewer kernels (whole kernels fetch higher prices than broken kernels).

3. Workers can achieve higher productivity (and earn higher wages) if processing larger kernels.

The total value increase (plantation + factory) is very significant and genetic selection is the biggest single improvement SES can make.

As indicated in section 2.1, all the planting at SES are seedling trees, the seed used come from an original seedling planting at Monte Christo island - and the origin of this is unknown. The use of this seed as a source for all planting at SES is a very self limiting procedure as it recycles a very narrow gene pool of relative unknown quality.

There has not been any analysis on the Monte Christo seed undertaken by SES to determine it´s genetic characteristics. However during a previous study by the consultant in El Salvador for CRECER (Review of Prospects for Cashew Production and Marketing, January 1997), the consultant undertook some trials on nut quality with crop samples from Monte Christo. These results showed the crop to have a reasonable recovery rate (27 %), however the kernel size could be significantly improved as only 7 % of kernel by volume could be described as being of good size.

There is a very significant opportunity for SES to improve the future value of it´s cashew planting by being involved in a cashew selection program to find superior new varieties and to produce grafted trees of these new varieties for future planting. The proposed selection program would involve the following:

1. Identify best 50 trees at Monte Christo based on the following criteria:

- Total yield
- Nut size
- Tree shape
- Early bearing

2. Select best 25 out of original 50 based on following additional characteristics:

- Total yield
- Kernel size (W240 grade is smallest size ie 240 kernels per lb)
- Recovery rate % (30 % recovery is the lowest acceptable)
- Tree shape
- Early bearing

3. Graft 30 progeny from each of 25 selected and plant in budwood block.

4. Monitor performance of clonal trees in budwood block for minimum of three harvests.

5. Commercial use of those varieties which meet desired standards.

In addition for longer term genetic improvement SES should import new genetic material - this would be as seed which represents a wide genetic variation and especially including Brazilian dwarf types. This seedling material can be planted in the budwood block and the performance monitored. The best of these seedlings can be grafted and these clonal trees can then be tested in the same method as indicated for the Monte Christo selections.

CORALAMA is already involved in a genetic improvement program so it makes sense for SES to be involved in cooperation with CORALAMA as both organizations could benefit from the same program at little extra cost. It must also be pointed out that while genetic selections are usually made for a particular environment, the similarity in climate between SES and CORALAMA should allow a sharing of selected varieties at both sites.

Note:

The above described genetic improvement program is a long term project as it will take a minimum of 5 years before any significant benefits can be obtained. In the meantime SES could commence an interim selection program as described below:

1. Interim selection program

Stages (1) and (2) are similar to stages in full selection program.

Stage (3) involves taking scions from selected parent, grafting in nursery and planting in the field.

The advantage of this method is that it gives a rapid result in the field with planting of improved tree in the field.

The disadvantages are:

1) That scion material is only coming from one tree so the number of trees that can be grafted will be very limited.

2) The grafted progeny from a parent tree is not identical to the parent due to rootstock/scion interaction. The value of the progeny evaluation stage where trees are tested in the budwood block is that it allows a complete assessment of the performance of that variety.

The interim selection method misses the progeny evaluation stage, so results are less accurate but it is worthwhile to save time.

The consultant recommends that SES undertake both the full and interim selection programs. They should not just do the interim program.

If SES decide to use both the full and interim selection process at the same time - then it could expand the number of original selections as far as practical. the following example shows how:

1. Identify best 75 - 100 trees at Monte Christo and in new planting based on following criteria

- Total yield
- Nut size
- Tree shape
- Early bearing

2. Select best 50 of originals on following criteria

S Total yield
S Kernel size (W240 grade is minimum ie 240 kernels per lb)
S Recovery % (30 % recovery is lowest acceptable rate)
S Tree shape
S Early bearing

3. For Full selection program graft 30 trees of each selected parent and plant in budwood block for evaluation.

Also for interim selection programgraft available trees and plant in the field.

C3. Crop Volumes and Implications

A summary of current trees numbers and trees ages in the SES project area and the consultant´s estimated future yield projections from these planting are as follows:

Current age of trees (years)	No of trees	Estimated yield (MT)		
		Current	2004	2009
25 +	2,000	30	25	20 *
4	3,230	1	17	32
3	325	-	1	2
2	3,550	-	11	28
1	3,525	-	9	24
	--------	-----	-----	----
	12,625 **	31	63	106

Note:

* Yield of mature trees will decline in the future due to tree age.

** This assumes original mature tree numbers are reduced by 30 % due to age and environmental factors, and all new planting by 5 % due to tree losses.

The implications of the above yield estimates are that the volume of crop is going to be insufficient to properly utilize the proposed factory capacity for a number of years (see section 2.3). It would appear that it will be another 6 years before the factory can work at 45 % of one shift capacity, and more than 10 years to work at 75 % capacity.

It should be pointed out that the volume of crop available to SES over the next 10 years could easily have been processed at CORALAMA with minimal additional capital investment.

C4. Pests and Diseases

C4a. Pests

Pests are a significant issue in cashew in virtually all cashew growing countries and they have the potential to cause significant damage to the crop. In some places losses of 50 % or more of the crop can occur in the absence of satisfactory control measures. A research paper by Pillai in 1979 reported 194 species of pests that attack cashew, a further 26 pest species were added by Rai in 1984 and in 1993 Sundararago recorded another 13. Of the pest species the vast majority of damage is caused by a relatively small number and that a number of these species are common in the major producing countries.

The major pest species can be divided into the following groups, flying insects like *Miridae* (*helopeltis)* and Coreidae *(amblypelta)* that attack nuts, flowers and the new flush, *Tripidae (thrips) and Monoleptera* that attack cashew leaves, Lepidoptera that damage foliage and various *Coleoptera* that are borers and attack the tree stem.

So far little is know of the bio-ecology regime of the cashew pests in El Salvador, however previous research by the consultant and others has identified that the dominant pest at CORALAMA to be *Leptoglossus sp* (*zonatus* and possibly others) and to a much lesser extent *Selenothrips rubrocintus.* Experience at CORALAMA has shown that damage has caused 40 % to 50 % of crop loss by *Leptoglossus.*

A visual inspection of the SES sites by the consultant indicated signs of the following:

1. Signs of apparent *Leptoglossus sp* damage on developing nuts. This will be the major pest.

2. Some evidence sites of thrips (*Selenothripa rubrocintus*) on cashew leaves.

3. Some signs of possible aphid damage, probably by *Aphis gossypii*. which is present in El Salvador.

At this stage the evidence of the scale of pest numbers and damage in the new plantations is limited, however the experience elsewhere shows that pest problems can only increase as the size and the number of cashew trees increase. Anecdotal evidence given to the consultant is that pest problems are also on the increase at Monte Christo, some years ago it was apparently minimal but now are now more obvious. All the evidence suggests that the pest situation at SES is very likely to be identical to problems at CORALAMA.

A previous report by the consultant (Report on Major Insect Pest Problem at CORALAMA, El Salvador, August 1997) identified information on the life cycle and behavior of *Leptoglossus* on cashew. The various stages of the life cycle are as follows:

Egg laying to hatching - 7 to 17 days

Nymph stage - 24 to over 100 days depending on Temperature,

Adult longevity - 48 to 260 days depending on temperature.

At CORALAMA it is understood that the *Leptoglossus* will probably be breeding outside the cashew plantation in crops such as *curcubits*, maize and moving into the cashew for feeding at the appropriate time when the crop appears on the trees (this situation will be further complicated at SES where the alternative host plants like maize are inter-planted with cashew). The *Leptoglossus* causes damage by pushes it´s proboscis through the developing shell of the nut to extract the nutrients. This then causes a necrosis on the damaged area on the kernel and destroys it´s value. The nut (in most cases) may appear to develop normally so this damage is usually discovered after processing.

Selenothrips rubrocintus is the other significant pest at CORALAMA but as a lower level than *Leptoglossus* sp.

As SES proposes to be an organic producer (like CORALAMA), it is limited to biological control measures. To date SES has been using applications of neem on the new planting to try and control pests, however previous research by the consultant established that neem is unlikely to have any significant effect on *Leptoglossus* and probably little on thrips. It was because of these issues that the consultant previously recommended the commencement of three bio-ecology and control studies by the University of El Salvador to be supported by CRECER. These studies commenced recently and include (1) Abundance and diversity of *Leptoglossus* sp in cashew plantations, (2) Organic control of *Leptoglossus* sp and (3) Organic control of thrips have been commenced.

Results are starting to come in form these studies at the university, the study on the abundance and diversity of *Leptoglossus* has identified one potential parasitic species and one potential predator.

In addition the consultant will now propose to CRECER a project regarding the introduction of a new predator species to El Salvador for trials in biological control. This species - the weaver ant, *Oecophylla smaradgina* which has proved to be an efficient predator of most cashew insect pests including the pests that are important in El Salvador. *Oecophylla sp* are indigenous in Australia, Asia and Africa but are not found in South or Central America.

The consultant believes that the research at the university of El Salvador supported by CRECER and the proposed project using *Oecophylla sp* will be equally important for SES in their program to control insect pests. It is for this reason that the consultant proposes cooperation between CRECER and SES in developing these programs for mutual benefit.

C4b. Diseases

Diseases are normally not a major issue in cashew. The only significant disease problems in cashew are fungus diseases. In East Africa powdery mildew (*Oidium sp*) is a major problem but is not significant else where. In some countries (as in El Salvador) anthracnosis can be a problem and it has been identified as an medium scale problem at CORALAMA. This year it appears to be much worse and this is apparently due to the changed environmental conditions caused by Hurricane Mitch. The inspection by the consultant at SES indicated signs of *anthracnosis* damage and this suggests that it could also be a future problem for SES.

Anthracnosis is a fungus disease caused by the causal agent, *Colletotrichum gloeosporioides.* This fungus particularly attacks new growth flushes and can thrive in certain environmental conditions, (humid conditions where temperatures remain below 30 degrees Cover a period of time and where cashew tree canopies are inter-grown). It can attack a range of crops including mango, paw etc which will complicate control at SES where alternative host plants are grown in close proximity to cashew. The normal management methods to control *anthracnosis* include (1) keeping the canopies of the cashew trees from growing into each other forming a dense foliage and (2) where necessary making timely sparays of copper solutions.

At SES *anthracnosis* is attacking young trees without dense foliage - in this case the consultant believes it may be caused by constant reinfection possibly from nearly alternative host plants or from trees in the forest and possibly are infection is occurring from biomass on the plantation floor. There has been speculation to the consultant by some sources in El Salvador that *Leptoglossus sp* may be a vector agent for *anthracnosis* - however there is, as yet no evidence for this theory.

The consultant concludes that *anthracnosis* appears to be a possible significant future problem for SES (as it already is for CORALAMA) and as yet we have insufficient knowledge on the infection cycle in El Salvador. Therefore the consultant is proposing to CRECER to initiate a study by the Plant Pathology department at El Salvador University to investigate further the infection cycle of *anthracnosis* in cashew plantations in El Salvador. We believe that if we better understand the infection cycle then we can design a better control system. In this event the consultant believes it would be in SES is interest to join with CRECER in supporting this program.

C5. Nutrition

In the past 25 years research has shown that cashew responds well very to applied nutrients. In these trials it has been shown that N and P were most important while the tree was in it´s vegetative growth phase, while K became important when the tree began to yield.

A major shortcoming of much previous research into cashew nutrition has been twofold. First, the fact that it was usually a measurement of responses to a small number of rates of N, P K (often 2-3) usually with little or no soil and leaf analysis undertaken before and after the applications of nutrition. In this event it has not been possible to determine response functions between yield, nutrient input, soil nutrient status and foliar analysis. Second, this research has virtually ignored the role of micro-nutrients. As a result to date our understanding of the nutrient requirement of cashew is still somewhat deficient.

Nevertheless nutrient standards for cashew have been developed and remain in use until new research makes refinements. The modern approach to nutrition of cashew is to consider the cycle as a nutrition balance. Trees use nutrients for (1) vegetative growth and (2) cropping the tree can extract nutrients from (1) the soil, (2) from recycled biomass and (3) from applied nutrients. There are also nutrient losses from leaching. To maintain the status quo the requirement for vegetative growth and cropping must be covered by nutrients from applied nutrients, the soil, and recycled biomass. Research by N. Richards in Australia has calculated that 15 % to 37 % of the nutrient requirements of the tree can be provided by recycled biomass.

Research, especially in India and Australia has calculated that 64 gm of N was required to produce one kg of nut and apple uptake. More recent research in Australia approaching completion (The Fertilizing of Cashew [1999] Dr N. Grundon) is predicting the level of macro nutrients required to cover levels of dry matter increments per annum in the tree. In recent years the importance of micro-nutrients especially zinc, boron and magnesium for cashew has been acknowledged. In particular deficiency of zinc can cause little leaf disease with significant implications for the crop.

While continuing research will eventually allow more refined calculations of applied nutrients, in the meantime it is recommended that the SES nutrition program rely on applying nutrients to correct any deficiencies as indicated by industry accepted nutritional standards as determined by the nutrient status of a healthy tree.

The accepted standards refer to nutrient levels as determined by foliar analysis (Kjeldahl or similar extraction method) and the nutrient standards currently in use in Australia where the knowledge of cashew nutrition appears to be more advanced are as follows:

Element	Deficient	Adequate
N %	<1.38	2.40 - 2.58
P %	<0.14	0.16 - 0.20
K %	<0.26	1.10 - 1.29
Ca %	<0.11	0.24 - 0.75
Mg %	<0.11	0.22 - 0.31
S %	<0.88	0.11 - 0.14
Cu (mg/kg)	<7	>7
Zn (mg/kg)	<12	>20
Mn (mg/kg)	<26	91 - 204
Fe (mg/kg)	<92	148 - 165
B (mg/Kg)	<39	56 - 67

The preferred time for a foliar analysis is the time of the pre-floral flush about November/December.

The suggested method of collection of samples for foliar analysis is to collect 4 leaves per tree from a minimum of 10 trees per manzana. The leaves collected should be the largest leaf of the vegetative flush. The results of the floral analysis will allow an application of nutrients at the time of vegetative growth in the tree, a critical time for nutrient requirement.

The compost used by SES has never been analyzed for it´s nutrient content, but the experience of CORALAMA would suggest that the applications are almost certainly insufficient to properly address the nutrient requirements. In the consultant's previous research (Report on Nutrition, SCPM Cashew Plantations in El Salvador, November 1997) it was found that 70 lbs of applied compost had insufficient nutrient content to sustain tree growth and sustain a crop of 5 kg of nuts + apple even allowing for expected biomass recycling and leaching losses. In this case SES only applies 5 lbs per year so the nutrient status is highly likely to be deficient. A possible outcome at SES based on the CORALAMA experience may be as follows:

N - deficient to very deficient

P - deficient to very deficient

K - deficient to very deficient

Ca - probably adequate

Mg - probably adequate

S - unknown

Cu - deficient to very deficient

Zn - just adequate to very deficient

Mn - probably adequate

Fe - probably adequate

B - probably adequate

A correction of N, P K deficiencies could best be corrected in compost by the use of the maximum amounts of poultry manure, legume based products (kudzu) and natural minerals such as natural gypsum and potassium chloride. The volume of compost applied per tree will have to be increased significantly, the exact amount to be determined by analysis. In addition the use of a cover crop like pintoi peanuts would increase the available N and reduce erosion.

Micro elements such as zinc, boron, manganese etc are more efficiently applied by foliar spray and this could be achieved by SES using their backpack equipment currently used to apply neem and copper solutions.

C6. Plantation Management Issues

SES is original objective appeared to been to inter-plant cashew with other crops. However since 1998 SES appears to have moved to a policy of higher density cashew only plantations.

Correct tree spacing is very important as cashew is a tree that only bears fruit on the peripheral of the canopy. In this event the most efficient spacing is that interval where the tree canopies when mature will not significantly grow into each other. The important issue to note here is that tree size and shape is highly genetically inherited and as a consequence the correct tree spacing is dependent on the variety of tree planted.

The problem of planting seedling trees is that their high degree of variation in tree shape makes it impossible to pick one correct spacing. For instance, currently there are seedling trees growing in many producing countries that could accommodate a spacing from as low as 15 meters by 15 meters (43 trees/hectare) to as high as 5 meters by 5 meters (400 trees/hectare). The correct choice of spacing for all trees in a plantation can only be done effectively when planting clonal trees where the final tree shape and size can be predicted with some reasonable accuracy.

The issue of genetic selection and improvement as described in section 3.3 is tied up with the benefits of achieving correct tree spacing for the selected clonal tree. In general a higher tree spacing provided the canopies do not inter-grow will achieve a higher yield.

SES staff also appear to have limited experience in management of cashew, both in the plantation and in processing. It appears that a one or two staff have attended cashew short grafting training courses, but apart from that their experience has been obtained on the job.

In order to make progress these staff will need more advanced technical assistance. Some assistance can be achieved by cooperation with CORALAMA who have growing cashew for some time, however SES would benefit from a continuing program of external technical assistance.

C7. Processing

The consultant makes comments on the following issues:

C7a. Size of Processing Factory

SES had previously made a decision to install a processing factory on site to process all their crop in-house. They had calculated that a processing capacity of about 140 MT of raw nuts would be adequate for the foreseeable future. Based on the consultant=s estimates of future crop (section 3.4) it will be over 10 years before this capacity will be utilized at reasonable efficiency levels (75 %).

It must be noted that a 140 MT capacity factory is very small by world standards a processing capacity of 1,000 MT p.a. is considered small. There are clear economies of scale in cashew processing capital costs and a 140 MT factory means a high unit cost. The following comparative figures give an example:

Capital cost (building/	Capacity (one shift/	Unit Processing

	equipment) (US$)	11 months) (MT raw nuts)	Cost (US$/MT)
MDR	550,000	1,000	550
SES	150,000 *	140	1,071

* estimate of amount allocated to nut processing only.

This compares an MDR mechanized shelling factory with the proposed factory, both factories would have a similar labor force.

It should be noted that the CORALAMA factory has the capacity to efficiently process the whole El Salvador crop for the foreseeable future and SES could process it´s crop at CORALAMA at a lower unit cost. However the consultant understands that there is a very strong local social benefits argument behind the decision to construct a processing factory at SES.

C7b. Type of Processing System

Processing of cashew involves a number of steps between raw nut and final product and these are as follows:

1) Raw nut stogare-------------------2)Cleaning / grading-------------3)Conditioning
↓
7) Peeling----------------6)Drying-----------------5)Shelling-----------4)Pre-shelling
↓
8)Grading----------------9)Grading---------------10)Packing----------11)Final product sale

In the major steps of (4) pre shelling preparation there are three different methods and in (5) shelling there two separate approaches.

The step of (4) pre-shelling involves preparing the raw nuts for shelling by making the shells easier to cut and (depending on system) allows extraction of cashew nut shell liquid (CNSL). There are three different methods of pre-shelling, these are as follows :

1. Dry roasting: that involves an near instant roast that burns off the CNSL.

2. Hot oil bath: that involves roasting raw nuts in bath of CNSL and this method extracts CNSL from the nuts.

3. Steam: involves steaming raw nuts in an autoclave. No CNSL is automatically collected, however this can be done if spent shells are processed through an expeller.

Each of the above systems have advantages and disadvantages, and this may depend on various factors:

There are two different methods of (5) shelling. These are:

1. Manual or semi manual: Manual methods are used in parts of India where shelling is achieved by use of a wooden mallet. Semi manual methods used in many countries involve using hand or foot operated cutting machines.

2. Mechanized: This involves using machines that shell nuts on mass, either by using centrifugal force (MDR, Peabody Sturtevant), or rapid automatic shelling of individual nuts *(Oltremare)*.

Manual or semi manual shelling can achieve higher quality final product and frequently appears to be preferred in very small scale processing factories (say 500 MT) or where labor is reliable and cheap. However when processing on a larger scale (500 MT) or where labor is scarce or more expensive then mechanized shelling systems become more attractive.

The processing design chosen by SES is essentially (4) hot oil bath pre shelling and (5) semi manual shelling system. The remainder of the processing steps would be similar to all other systems.

The consultants brief comments on the proposed proposed processing system are as follows:

1. In general experience from India and elsewhere suggests that steam systems are more cost/efficient work than hot oil bath in low capacity systems as being constructed at SES. The steam advantages are as follows:

S Steam systems are cheaper to install and easier to operate. Hot oil bath systems are more efficient when operated at a larger scale. This is because at low levels the CNSL hot oil bath does not work well as the oil can become too viscous during operation.

S At a small scale and properly operated they can produce higher quality final quality (in terms of higher % white kernels).

S Hot oil bath systems may require higher skilled operators.

S Steam systems can have greater worker acceptance due to cleanliness factors.

2. The advantage of hot oil bath is that the process automatically collects CNSL (while the steam system does not). This advantage is probably overrated as the net value of CNSL sales from one MT of raw nuts (say US 25) are a very small proportion of the value of the kernel (say US$1,200).

The consultant=s comments on the choice of (5) shelling technique is as follows:

S The machines chosen have been successfully used elsewhere in the world in smaller scale factories but they have some element of danger for the operatives during the cutting process and there must be proper training and supervision for the workers. This is a significant issue so SES so should have technical assistance for the training of workers.

S Mechanized shelling is only cost efficient in higher capacity systems, they are also much safer and have a higher degree of cleanliness for the workers.

C7c. BudgetItems for the Factory

Based on information given to consultant he questions the relative costs in the factory budget for the processing equipment of (1) the kernel (US$ 35,050), (2) CNSL (US$ 27,488) and (3) dried fruit (US$ 20,522). While the consultant is aware of the specialized equipment required for processing of kernel, he is unaware of what specific items of equipment are to be purchased for (2) CNSL and (3) dried fruit.

There appears to be a disproportionate expenditure on the minor by-products. The kernel is by far the most valuable product has a well established export market, by contrast CNSL will only provide about 2 % of the revenue provided by kernels. The market for cashew dried fruit is completely unknown. To the consultant´s knowledge there is no export trade in this product and there is certainly no trade in El Salvador. It would appear that before SES can embark on the production of dried fruit it is going to have to establish a market.

The budget also includes US$ 4,947 for processing equipment of cashew apples into juice and US$ 39,369 for refrigerated trucks. Cashew apple juice is a well defined by product in a few countries, especially Brazil. However currently there is no established export market in cashew apple juice or other cashew apple products. Therefore SES will have to develop a new market overseas (expensive) or in El Salvador or nearby in Central America. There is no commercial production of cashew apple juice in El Salvador but the population is aware of cashew. The potential markets in El Salvador would be for juice as (1) straight cashew juice and (2) as a filler juice in a juice mix, of these markets (2) may be easier to enter. However as it is a new product cashew juice will have to discount price in order to make a market entrance.

It should also be noted that in order to utilize cashew apples it will be necessary to harvest the crop virtually every day and this can raise harvesting costs considerably.

4. Recommendations on Critical Issues

D1. Genetic Improvement

The consultant recommends a joint SES - CORALAMA genetic improvement program which would be as follows:

1. Appoint one person (genetic improvement officer, GIO) to have responsibility for the management of the genetic selection program at SES. (in the event of cooperation with CORALAMA it may be possible for the appointed person to supervise both SES and CORALAMA and CORALAMA genetic improvement programs.

2. The following infrastructure to be installed at SES, like already installed at CORALAMA:

- Nursery, with facilities for propagation (shade cloth and irrigation).

- A five manzana budwood block where the new selections would be planted for evaluation.

3. Worker training for grafting (and top working of old trees), and of nursery techniques for SES staff. It is understood that a few SES staff have training in this area.

The program for tree selection, propagation and evaluation as described in section 3.3 for the full selection program should be followed. SES is also wise to consider operating the interim selection program also described in section 3.3.

The source parential material for SES will be (1) Monte Christo trees and (2) imported genetic material. In addition there should be cooperation between SES and CORALAMA in this program so that superior material can be shared between both sites.

D2. Pest and Disease Management

SES future entomology problems are almost certain to be virtually identical to those already being experienced at CORALAMA. CRECER is already supporting a bio-ecology study by the University of El Salvador concentrating on *Leptoglossus sp* and *Selenothrips rubrocinctus.* In this event it makes economic and management sense for SES to cooperate with CRECER and CORALAMA to resolve these issues.

The consultant recommends that SES join CRECER in supporting both the following research programs as they will be of significant benefit to SES:

1. Entomology project being carried out by University of El Salvador.

   This project is in three parts (1) Abundance and Diversity of Cashew Insect pests in EL Salvador, (2) Trial of Organic Products to Control *Leptoglossus* and (3) Trial of Organic Products to Control Thrips.
2. New study proposed by consultant for introduction and trials of <u>*Oecophylla sp*</u> as a biological control agent as described in section 3.5.

Anthracnosis, the fungus disease also appears to becoming a significant problem for SES (as it is elsewhere in El Salvador). SES is recommended to keep making timely sprays of copper solutions *(Kodicide)* when required. In addition the consultant is proposing to CRECER that a new research program be undertaken by the University of El Salvador to gain more information about the cycle of re-infection that appears to be occurring in the cashew plantations. Only when we understand more about this will we be able to work out more affective solutions. The consultant would recommend to SES that they join CRECER in supporting this additional work.

D3. Nutrition Program

The following steps should be taken:

1. The compost currently used should be analyzed for nutrient content.

2. Foliar analysis should be undertaken from all new plantings of cashew to determine nutrient status of the trees (the procedure for the taking of samples and the analysis in described in section 3.6).

3. Volume of compost applied will have to be increased. It is impossible to apply sufficient nutrients in 5 lbs compost. The correct volume of compost to be applied can only be calculated after both nutrient analysis of the compost ingredients and foliar analysis of the trees has been undertaken.

4. The nutrition program should be modified as much as possible to improve it´s status as described in section 3.6. This includes the use of more legume based products like kudzu and the addition of poultry manure, natural mineral salts such as natural gypsum, potassium chloride and the planting of pintoi peanuts as a cover crop.

   The application of micro-nutrients such as zinc, boron etc is best done by the use of a foliar application using the back pack sprayers that SES already have.

D4. Plantation Management

The consultant makes the following recommendations on the following issues.

D4a. Site Selection for Future Plantings

SES should undertake analysis of the soil structure (% sand, silt, clay) to depth of 2 meters, together with pH analysis. Only sites with suitable soil profiles should be planted. The preferred sites would have sand profiles of 75 % or more and pH of 5.5 to maximum of 7.0.

D4b. Planning for Future Plantings

The issues in the planning of tree spacing for future plantings is described in section 3.7. Assuming that SES continues with it´s policy of planting cashew only plantations then it is suggested that using a 12 meters by 6 meters spacing is impractical and will limit the ultimate yields of the trees. This spacing is unbalanced, the 12 meter spacing should be more than enough to accommodate most canopies, while the 6 meter spacing will be too narrow for most tree canopies.

Instead it is recommended that they follow the guidelines indicated below:

1. In the near future when using Monte Christo seed to make new plantings they should use a tree spacing of either (1) 8 meters by 8 meters (155 tree/hectare) or (2) 9 meters by 9 meters (123 trees/hectare). The choice of which spacing to use will depend on their appreciation of the ultimate size and shape of the tree canopy.

2. In the longer term the tree spacing can be adjusted to suit the exact size of the clonal trees planted. (for example use of some Brazilian dwarf clones may even allow a spacing of 5 meters by 5 meters (400 trees/hectare).

D4c. Climate Monitoring

Rainfall, temperature and humidity data can be easily collected and this should be undertaken so as to improve the understanding of the environment in which cashew is grown at SES. This would involve very minimal investment.

D4d. Technical Assistance and Staff Training

SES should take steps to improve the skill levels of it´s staff in both plantation and factory. In the plantation this can be achieved in the following ways:

S Cooperating with CORALAMA in the genetic improvement and entomology programs (see section 3.3 and 3.5).

- Arranging on going technical assistance program from an authoritative source. This is likely to be external as good knowledge on cashew is limited in El Salvador.

D4e. Processing and Marketing

SES has already made the decision on the size and type of processing system to be installed in it´s new factory. The consultant=s comments on this choice are contained in section 3.8.

5. Brief Review of World Cashew Market

E1. Introduction to Cashew

Cashew (Anacardium Occidental L), is a tree of the dry tropics which originated in north east Brazil. It was spread by the Portuguese in the 16^{th} and 17^{th} century to East Africa and India (Goa) and later mover to many tropical countries.

The cashew is unique in that the tree produces a nut that is external and is attached to the fruit. The nut is processed to release the kernel which is the main product that is utilized as an edible nut. The shell of the nut also contains cashew nut shell liquid (CNSL), a natural phenol that can be collected during processing as a by product and has a number of industrial uses as a heat resistant material. The fruit, also known as the cashew apple has a number of uses including eating as fresh fruit by the growers to a number of industrial uses where conditions allow (fruit juice etc).

Cashew is grown in a large number of countries, production is largely by small holder farmers. Only in Brazil are there some large scale plantations, but even there small holders are important. Generally world cashew production has been with low technology using seedling trees and few inputs. Results are also low however because of low labor costs in growing countries the returns have been adequate.

In some countries in response to rising costs efforts are now starting to be made to increase returns. This involves an improvement in the technology of growing cashew using selected grafted trees and more inputs.

E2. Production of Cashew Nuts

The current major producers are India and Brazil and more recently Vietnam. Up to the mid 1970s Mozambique and Tanzania were with India the largest producers but subsequent political and other problems in East Africa saw a major decline in their crop by the early 1980´s. This caused a fall in world supplies and a resulting escalation of kernel prices. These higher prices stimulated increased production from India, Brazil and 'new entrants' especially Vietnam and other countries in South Asia.

Table 1.

World Production (000 MT Raw Nuts)

	91/92	92/93	93/94	94/95	95/96
India	305	349	340	321	310
Brazil	190	120	170	210	200
Mozambique	54	24	29	33	40
Tanzania	40	39	47	30	50
Vietnam	30	40	60	90	120
Kenya	18	24	20	20	20
Guinea Bissau	10	18	15	31	30

Notes:

1. Others include Sri Lanka, Thailand, Madagascar, Togo, Ivory Coast, Benin, El Salvador, Venezuela, Guatemala, Philippines etc.

2. There is no accurate published data on world production, the above table are estimates based on trade sources. Of the total world crop perhaps only about 65% enters the world trade. Some part of

the crop is consumed in the villages while another part is processed locally and sold as product in the local retail trade. There is a very large domestic market in India and in some SE Asian countries where there is a national preference for cashew in the diet.

E3. Development of Cashew Processing and Raw Nut Export Trade to India

Up to the 1960's virtually the whole world's crop was processed in India where very cost efficient hand processing methods had been developed. During this time the Indians controlled the international trade in processing and marketing of cashew. Apart from their own crop they imported increasing volumes of crop that was becoming available from Mozambique and Tanzania. By 1960 India processed and marketed 95 % of all traded product.

The dominance of the world trade by India was sustained by the scale of the raw nut import program, especially from Mozambique and Tanzania which peaked at about 200,000 MT in 1972. At this time the total world crop was less than 400,000 MT.

During the 1960´s and 1970´s newly designed mechanical processing factories were installed in East Africa and together with the reduction of crop in those countries encouraged the Indians to expand their local production as well as diversify their sources of raw nut imports. In recent years Vietnam especially, Indonesia and West Africa have become more important sources of raw crop. However this trend is now changing as Vietnam is now encouraging local processing.

Table 2. Indian Raw Nut Imports (000 MT Raw Nuts)

Country of Origin	1993	1994	1995	1996
Tanzania	38,368	55,658	51,346	82,384
Mozambique	19,908	n a	7,665	27,197
Vietnam	26,516	43,898	14,109	nil
Indonesia	13,517	25,821	13,706	16,563
Guinea Bissau	9,058	31,410	29,156	9,180
Ivory Coast	5,621	19,128	23,793	10,814
Others	27,511	80,546	53,650	56,208
Total	135,544	276,369	193,125	202,34

Table 3. Raw Nut Import Prices (US$ c & f)

Country of Origin	1992	1993	1994	1995	1996
Guinea Bissau	1,060	1,133	1,004	1,050	1,192
Indonesia	984	902	905	979	1,068
Ivory Coast	1,039	944	983	920	900
Mozambique	787	796	822	700	930
Nigeria	919	709	793	860	789
Tanzania	1,090	777	860	915	-
Vietnam	1,020	832	1,069	1,006	900

The processing industry in India employs about 300,000 people (mainly women) and is estimated to have a capacity to process 500,000 MT raw nuts p.a As domestic production and imports have not reached this level the industry has previously operated well below capacity. However this spare capacity is being reduced as Indian local production expands.

In Brazil the processing industry has developed to process the whole crop mainly using mechanical methods. This development has bee aided by a ban on raw nut exports. In Africa and SE Asia the producing countries have a mixture of local processing and raw nut exports to India. While these producing countries would no doubt prefer to process all their crop and sell kernel they face very strong price competition from the Indian raw nut trade who probably have an advantage of about US$ 150 to US$ 200/MT that reflects their cost efficiency in processing.

The prices paid by the Indians for raw nut imports could be reduced in the future as their local production increases to meet local processing requirements, however this point is probably 10 years or more away.

E4. Supply of Kernel

India has been the dominant supplier of kernel but Brazil is also important especially to the US market. Tanzania and Mozambique were previously important suppliers but are now relatively small. In recent years Vietnam has become a major source of kernel.

Table 4. Exports of Kernel (MT)

	1993	1994	1995	1996	1997
India	62,817	78,266	72,436	70,190	74,863
Brazil	29,914	22,709	31,896	36,229	36,297
Vietnam	5,512	9,528	18,162	26,111	32,894
Mozambique	2,654	892	453	**	**
Tanzania	45	nil	113	**	**
Others	2,858	4,996	5,184	11,365	11,343
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Total exports	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Source : Mann Producten Rotterdam

Note:

* Total kernel exports in others category are probably underestimated by 2,000 to 3,000 MT as some minor exporters may be missed.

E5. Kernel Consumption

The total annual world trade in kernels is now above 130,000 MT. The USA is the dominant market and takes about 50% of world trade. The other important markets are UK, Netherlands, Canada, and Japan. China has become a significant market in the past few years.

Table 5. Kernel Imports (MT)

	1993	1994	1995	1996	1997
USA	59,954	61,632	52,677	59,029	65,108
Netherlands	8,593	13,354	8,552	12,409	14,065
Germany	6,892	8,412	9,642	10,821	11,683
Canada	5,537	4,781	4,151	4,537	5,217
UK	6,510	6,019	5,127	6,374	7,032
Japan	5,622	6,193	6,420	6,556	6,578
Australia	3,771	4,488	na	na	
China	4,990	7,509	14,995	17,513	20,417
Others	10,606	12,477	23,753	27,860	
Total	107,485	117,356	125,317	145,099	156,760
re-exports	6,265	10,154	13,000*	16,000*	20,000*
Net imports	101,220	107,202	112,317	129,099	136,760

Source : Mann Producten Rotterdam.

Note :

* Re-exports occur mainly from Rotterdam (Netherlands) and also from Hamburg (Germany) and London (UK).

* Shows estimate of volume of re-exports.

In addition to the major traded markets (above) there is also a very large consumption of cashew at the retail level in India supplied from domestic production. There is no accurate data on this market but it is estimated by trade sources to be about 25,000 MT kernel and growing strongly. There is also significant consumption of cashew from domestic production in Thailand, Indonesia, and an emerging markets in China.

E6. Kernel Prices

As the US is the world's largest importer it is the New York market the effectively sets the world prices in US dollars per lbw. The W320 grade (300 to 320 whole white kernel per lbw) is used as the benchmark for all price quotes, larger white whole grades are sold at a premium while scorched, dessert, smaller wholes and broken grades are sold at a discount.

The following table of a recent quote from a major trader demonstrates the relative prices for some of the most frequently traded grades as follows:

Table 6.

Grade	Description	Price (US$/lbw)
210	white whole	2.90
240	white whole	2.60
320	white whole	2.35
450	white whole	2.14
SW	scorched whole	2.12
FB	fancy buts	1.80
FS	fancy splits	1.75
LWP	large white pieces	1.60
DW	desert wholes	1.60
SWP	small white pieces	0.70

Source : Consultant´s private data.

The benchmark price usually reflects Indian product - kernel from other sources may be discounted depending on previous quality and reputation. Prices are mainly set by supply and demand factors. However future crop expectations can cause price fluctuations especially as there is frequently a back ground of limited accurate data.

In the period 1975 to 1980 kernel prices more than doubled reflecting the shortage of crop brought about by the fall in production in Mozambique and Tanzania, Apart from a few temporary reversals prices remained at higher levels until early 1989. In the past 6 to 7 years prices have remained at more moderate levels and this has encouraged a very significant expansion in consumption.

Table 7

Kernel Prices (US$ per pound)		W 320 Grade
		US$
1985		2.40
1986		3.17
1987		3.18
1988		2.98
1989		2.46
1990		2.39
1991		2.75
1992		2.47
1993		2.38
1994		2.40
1995		2.56
1996		2.68
1997		2.50
1998	(to Sept)	2.47

Source : Mann Production, Rotterdam

E7. Outlook for World Market

World production has expanded very significantly in the past 10 - 15 years encouraged by the period of high prices during the early to mid 1980's. However in the past few years affordable kernel prices have lead to a large expansion in the market. (the trade considers wholesale prices of W320 grade above US$ 3.00/lbw as being regressive on retail demand).

It is expected that in the immediate future world production will continue to increase, the underlying trend is about 5% to 10 % p.a. This is because India is continuing to expand to try and meet it's domestic processing requirements while producers in other countries (Brazil, Vietnam. etc) have land available and find it profitable. In Tanzania and Mozambique the industry is now recovering slowly.

On the demand side apart from further growth in the mature markets (USA Europe) etc. there is significant potential for market growth in India, S.E. Asia and China.

The estimate is that apart from occasional temporary reversals due to climatic factors, demand and supply factors should remain approximately in the current balance and current prices should be maintained for the immediate future.

E8. Cashewnut Shell Liquid CNSL

CNSL is a natural phenol (90 % anacardic acid) contained within the shell and is a by product associated with the processing of cashew. The volume of CNSL contained in the shell may vary but in practice some 8 % to 10 % can be recovered depending on raw nut quality and processing method used.

90 % of the CNSL collected is processed into resins for use as fillers in auto brake linings and clutch facings. Other minor uses include marine paints and varnish. There are competitor products to CNSL

in the auto industry, some of which the synthetic phenols out perform CNSL. However the manufacturers prefer to use CNSL as long as the price is competitive.

The major markets for CNSL are USA, UK, Japan and South Korea. Total world supply of CNSL is estimated at about 45,000 MT with an average price of about US$ 300/MT. Brazil is the major supplier (about 25,000 MT) because the processing system they use (hot oil bath) automatically extracts CNSL. In India and in some other countries only a small fraction of the potential CNSL is collected because of the different systems of processing used. However if the price of CNSL increased significantly these processors could change their processing methods and collect CNSL, this acts as an automatic brake on world prices.

E9. Cashew Apple

The production of cashew apples is 5 to 10 times the volume of the nuts produced however in most producing countries little economic use is made of the apple. The most likely outcome is the consumption of the apple as fresh fruit. Only in India and Brazil is any significant commercial use made of the apple and even there only a small fraction of the potential crop is utilized.

The cashew apple is a highly perishable fruit, which is about 85 % moisture, therefore it needs to be harvested virtually on a daily bases if it is to be utilized. The apple is of value also because it is higher in vitamin C and B than most other fruits.

Contents per 100 gm

	Cashew Apple	Orange	Lime
vitamin C (mg)	186 - 240	49	45
vitamin B 12 (mg)	99 - 124	30	trace
Source J G. Ohler			

Source: J. G. Ohler

In Brazil the annual production of juice exceeds 30,000 MT p.a. and a number of other cashew apple products are produced. In India the Central Food Technology Institute has undertaken research into the uses of the apple and there is now significant commercial use of the apple in some areas (juice, tinned fruit, chutney, candy, brandy, whisky, liqueur etc.).

E10. The Market for Organic Cashew Kernels

The marketing of organic cashews is a very recent phenomena and there is little accurate data available on the parameters of this market. The total world market currently is very small, probably no more than 500 MT p.a. (200 MT Europe, 200 MT N America and 50 MT elsewhere). This is about 0.3 % of total world consumption. However according to one European importer the market is growing at 10 % to 15 % p.a. The market appears very much concentrated in western countries and the current demand is mainly from particular health conics customers. There is little information on the market position in Japan - which is the largest Asian importer of cashew.

Currently there appear to be only a few producers who are growing organic cashew although this number is growing. Apart from CORALAMA the organic projects known to the consultant include two growers in Sri Lanka, one in India and one in Brazil. The certification status of these other projects is not known.

The importers of organic cashew in North America include Ports West International of Canada and Nut Butter Nunda in USA. The import of organic cashew into Europe appears to be dominated by three organizations (Horozon Natuurvoeding Holland, Rapunzel, and Care in Germany) that apparently import 75 % of the European consumption (200 MT).

Demand for organic product is estimated to increase in the next few years but this will be influenced by price. In the past few years the premium for organic cashew has been high ranged from 50 % to 100 % over normal wholesale levels. However the premium is expected to decrease as organic supplies.